Thermal Diffusivity Measurements Using Dynamic Light Scattering

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Direct measurements of the thermal diffusivity and thermal conductivity of fluids require the introduction of a macroscopic temperature gradient. Light scattering measurements of thermal diffusivity do not require such a gradient, thus eliminating potential measurement errors arising from nonequilibrium conditions. This is particularly important for measurements of the thermal diffusivity of the saturated liquid and vapor where the approach to saturation is limited by the magnitude of the measurement temperature gradient. The isothermal nature of light scattering makes it particularly useful for studies in the vicinity of the gas-liquid critical point where the fluid convects easily and the fluid properties change dramatically with small changes in temperature.

The thermal diffusivity of several fluids was measured as a function of pressure and temperature using the method of low-angle dynamic light scattering. The uncertainty of the measured pressure and temperature is carefully examined since close approaches to the gas-liquid critical point are required. Measurements of the thermal diffusivity of carbon dioxide are compared with those from previous dynamic light scattering studies and with values of thermal diffusivity and thermal conductivity obtained using other methods. The uncertainty of the thermal diffusivity data obtained with the present apparatus is estimated.

The thermal diffusivity of a fluid approaches zero at the gas-liquid critical point. This strong nonlinearity in the critical region can be used to accurately determine the gas-liquid critical point parameters. Values for the critical point parameters of the fluids studied are also reported and compared with published values where possible.